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Measurements for the Household - 1917

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The Commonwealth of Massachusetts

MEASUREMENTS FOR THE HOUSEHOLD

SECOND EDITION, JANUARY, 1917

Issued by

THE COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF WEIGHTS AND MEASURES

THURE HANSON, Commissioner

STATE HOUSE, BOSTON

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
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INTRODUCTION.

The purpose of this pamphlet is (1) to give information as to units, methods and instruments of measurement useful in household activities; (2) to describe available means of assuring correct quantity in articles bought by weight and measure; and (3) to give other facts of interest which would awaken an appreciation of the rôle of measurement in daily life.

It was with the purpose of making the results of the work of the Department of Weights and Measures available to the public in so far as this work is related to the work of the household that the first edition of this pamphlet was published in July, 1916.

The publication met with instant popular favor, and the entire edition was exhausted within thirty days. Applications for copies have since been received from several hundreds of housekeepers and, in order to meet this demand, a second edition was authorized.

Some few changes and additions have been made with a view to increasing the value of the work, and credit is due to the United States Bureau of Standards for much of the subject-matter and many of the illustrations contained in this publication.

Thure Hanson,

Commissioner.

STATE HOUSE, BOSTON, January, 1917.

MEASUREMENTS FOR THE HOUSEHOLD.

GENERAL SUGGESTIONS TO HOUSEKEEPERS.

The efficient management of the modern household is greatly promoted by the careful use of proper weighing and measuring appliances and the exercise of due care on the part of the housekeeper in seeing that the quantity of commodities delivered coincides in all cases with that purchased and paid for, and the purpose of this circular is to serve as a guide to thrifty housekeepers.

Within the last decade radical changes have been made in the laws, until to-day all weighing and measuring devices in commercial use must be sealed and accurate; all sales of commodities must be made under such conditions as to prevent fraud or mistake; and the Commissioner of Weights and Measures, his inspectors and the local sealers of weights and measures are empowered to enforce these enactments.

While this legislation has resulted in vast improvement in methods of merchandising, these officials cannot supervise all sales which are made, and it is only by the purchasers knowing what they are entitled to, and insisting upon getting it, that they can be fully protected.

In general, the customer should see that the scale is in balance, or that the indicator is at zero, when there is no load upon the scale; that there are no attachments which appear to be unnecessary or foreign to the weighing or measuring device; and that no paper or other article is placed upon the pan or attached to any movable part of the scale.

A legal weight has now been established for nearly all fruits and vegetables, and the use of the measure is illegal in the sale of any of these; the measures may still, however, be used in the sale of nuts and berries, and care should be taken to see that the standard dry quart measure is used and not the liquid quart, which contains approximately 15 per cent. less than the dry quart.

When purchasing fruit or vegetables from a hawker or pedler, you should see that he uses a scale instead of a measure in making the sale, also observing the number of his license so that he may be easily traced in case of complaint.

Marking of Food Packages.

Chapter 653, Acts of 1914, which became effective on Sept. 3, 1915, requires that all articles of food sold or offered for sale in package form shall be plainly and conspicuously marked with a statement of the net quantity of the contents on the outside of the package in terms of weight, measure or numerical count.

Purchasers are urgently requested to notify this Department of all cases coming to their attention where food sold in package form does not bear the required statement of contents, or where this statement is not so placed and in such characters as to be readily seen and clearly legible when the size of the package and the circumstances under which it is ordinarily examined by purchasers or consumers are taken into consideration.

Definition of Term "Food."

The term "food," as used in this act, includes all articles, whether simple, mixed or compound, used for food, drink, confectionery or condiment by man or other animals.

Comparison of Foods in Bulk and Package Form.

Up to this time, in purchasing food commodities in the original package the housewife has usually been limited to comparisons of quality and apparent price, which is of course the price per package. In comparing two brands of a food in packages of equal size these comparisons were trustworthy. When there was a difference in the size of package, however, economy in buying could not be obtained from a knowledge of these two factors alone. There might be a large difference in price per unit of quantity which would outweigh an apparent difference in price per package, or slight difference in the quality; but with the quantity labeled upon each package the purchaser has all essential facts at hand to compare unit prices.

Thus, we may compare two brands of package goods. Two packages of raisins sell for 10 cents and 12 cents per package, respectively. The purchaser might consider that the 12-cent brand was worth

2 cents (or 20 per cent.) more than the 10-cent brand, but upon examination of the labels, however, if it appeared that the former contained 16 ounces and the latter only 12 ounces, he might conclude that the difference in price outweighed the advantages conceded for the higher priced package.

Again, a package of crackers may sell for 10 cents per package and crackers in bulk for 10 cents per pound. The purchaser might consider the package goods more desirable and disregard the weight. Under these conditions the package brand would naturally be

FIG. 1. — Three bottles of extract (front and side views).

This shows the impossibility of correctly estimating the quantity of contents from apparent size of the container. The bottle which is apparently smallest holds the most, and *vice versa*.

selected. But the quantity is now marked on the package. Suppose in the case mentioned above the weight is 10 ounces. The cost per pound of the package goods is therefore 16 cents and of those in bulk 10 cents. The knowledge thus conveyed, that the brand somewhat better in quality or flavor was 60 per cent. higher in price, might entirely outweigh the slight difference in quality and persuade the purchaser that the bulk goods were the better for the purpose. Therefore the careful purchaser should first examine the labels on the packages, observe the net contents, and determine therefrom the price per unit weight. If these precautions are neglected much of the value of an excellent protective statute will be lost.

MASSACHUSETTS' PRINCIPAL INDUSTRY — HOUSEKEEPING.

Precautions to be observed in Making Purchases.

If you are engaged in this industry you should —

Trade with dealers who have accurate and sealed weighing and measuring devices.

Check up all goods received, to ascertain if full quantity has been delivered.

Purchase package goods which are legibly marked on the outside of package with the net quantity which it contains.

See that your milk and cream bottles are filled to the cap or stopple.

The coal dealer is required by law to deliver to you a sworn statement as to the weight delivered. See that you receive such a certificate.

If any coal dealer neglects to give you a certificate stating the number of pounds contained in a load that is being delivered to you, the local sealer of weights and measures should be promptly notified.

In purchasing ice be careful to ask for a certain weight of ice, viz., 50 pounds, 75 pounds, 100 pounds, and do not be content to accept 10-cent, 20-cent, 30-cent pieces.

In purchasing meats request that all "trimmings" be included with purchase; otherwise a correct check of goods cannot be made.

In purchasing turkey, chicken, etc., do not accept the weight as sometimes already marked on the same, but insist that the commodity be reweighed in your presence.

Equip your kitchen with a good scale of 10 to 20 pounds capacity, weighing in ounces, and have it tested and sealed annually by the local sealer of weights and measures. Use this scale for checking all weights of commodities delivered, and if under weight is found to exist, do not fail to bring each case to the attention of the dealer. The shortage may be due merely to carelessness, but you are entitled to full weight, and he should know that you are a business woman and will not countenance unbusinesslike methods in his dealings with you.

Also have on hand an accurate dry quart, a liquid quart, a 60-inch steel tape, an 8-ounce graduate. These should also be submitted to the sealer for test.

Be businesslike when purchasing. The merchant is careful that

in his sales he receives full value for correct weight or measure given. He is obliged to be thus careful, else his business would be done at a loss. Why then should the *business of housekeeping* be done in a careless manner and at a loss. Order commodities in terms of weight

FIG. 2. — Thrifty housekeeper.

and measure. Do not order a "pail of lard," "print of butter," "30-cents worth of potatoes," "piece of bacon," "can of oil," "box or basket of fruit," unless you know how much that pail, print, package, etc., contains in weight or measure.

Refuse to accept a bill from your tradesman made in the following manner: —

Beef,	$0 40
Butter,	35
Oil,	15
Lard,	10

Insist that a bill be rendered in the following manner: —

Beef, 1 pound 6 ounces,	$0 40
Butter, 1 pound,	35
Oil, 1 gallon,	15
Lard, 1 pound,	15

Penalty for giving False Weight or Measure.

SECTION 1, CHAPTER 394, ACTS OF 1907, AS AMENDED BY CHAPTER 163, ACTS OF 1911.

Whoever, himself or by his servant or agent or as the servant or agent of another person, gives or attempts to give false or insufficient weight or measure shall for a first offence be punished by a fine of not more than fifty dollars, for a second offence by a fine of not more than two hundred dollars, and for a subsequent offence by a fine of fifty dollars and by imprisonment for not less than thirty nor more than ninety days.

Under the laws of the Commonwealth of Massachusetts you have definite rights in the matter of getting full measure and full weight of everything you buy, and the State Department of Weights and Measures and your local sealer stand ready to help you get your rights. *This is a protection that is due the honest dealer as well as yourself.*

You are probably very careful in making your purchases to require *good quality*. Should you not be as careful as to *quantity* received for the amount expended?

The retailer checks up all goods received. If he sells intelligently, he sells most of his commodities by weight. The housekeeper should be as careful when purchasing.

The State Department of Weights and Measures and your local sealer want your co-operation in the cause of honest weights and measures.

Do not accuse any merchant of giving short weight unless you are absolutely sure. It may be that your scales are wrong, and you would be doing a great injustice to the merchant. When in doubt always have your goods reweighed by the sealer.

SECTION 21, CHAPTER 57, REVISED LAWS, AS AMENDED BY CHAPTER 246, ACTS OF 1912, AND CHAPTER 713, ACTS OF 1913.

All fruits, vegetables and nuts, except as hereinafter otherwise provided, shall be sold at retail by dry measure, weight or by numerical count, and all fruits and vegetables for which a legal weight has been established, except peas and beans sold in quantities of four quarts or less for seeding or planting purposes, shall be sold at retail only by weight or numerical count. Whoever violates any provision of this section shall forfeit a sum not exceeding ten dollars for each offence.

Legal Weight of Bushel or Barrel of Various Commodities.

Weights of One Bushel, One Peck and One Quart of Certain Vegetables, etc., as provided by the Laws of Massachusetts.

COMMODITY.	1 BUSHEL.	1 PECK.	1 QUART.	
	Pounds.	Pounds.	Pounds.	Ounces.
Apples,	48	12	1	8
Apples, dried,	25	6¼	–	12½
Barley,	48	12	1	8
Beans,	60	15	1	14
Beans, Lima,	56	14	1	12
Beans, shell,	28	7	–	14
Beans, soy,	58	14½	1	13
Beans, scarlet or white runner pole,	50	12½	1	9
Beans, string,	24	6	–	12
Beans, Windsor (broad),	47	11¾	1	7½
Beets,	60	15	1	14
Beet greens,	12	3	–	6
Bran and shorts,	20	5	–	10
Buckwheat,	48	12	1	8
Carrots,	50	12½	1	9
Corn (cracked),	50	12½	1	9
Corn, Indian,	56	14	1	12
Cranberries,	32	8	1	–
Dandelions,	12	3	–	6
Feed,	50	12½	1	9
Flaxseed,	55	13¾	1	11½
Kale,	12	3	–	6
Lime,	70	17½	2	3

Weights of One Bushel, One Peck and One Quart, etc. — Concluded.

COMMODITY.	1 BUSHEL.	1 PECK.	1 QUART.	
	Pounds.	Pounds.	Pounds.	Ounces.
Meal, corn,	50	12½	1	9
Meal, rye,	50	12½	1	9
Millet, Japanese,	35	8¾	1	1½
Oats,	32	8	1	–
Onions,	52	13	1	10
Parsley,	8	2	–	4
Parsnips,	45	11¼	1	6½
Peaches,	48	12	1	8
Peaches, dried,	33	8¼	1	½
Peanuts, green,	22	5½	–	11
Peanuts, roasted,	20	5	–	10
Pears,	58	14½	1	13
Peas, smooth,	60	15	1	14
Peas, unshelled, green,	28	7	–	14
Peas, wrinkled,	56	14	1	12
Potatoes,	60	15	1	14
Potatoes, sweet,	54	13½	1	11
Quinces,	48	12	1	8
Rice, rough,	44	11	1	6
Rye,	56	14	1	12
Salt,	70	17½	2	3
Seed, clover,	60	15	1	14
Seed, herds grass or timothy,	45	11¼	1	6½
Seed, Sea Island cotton,	44	11	1	6
Seed, upland cotton,	30	7½	–	15
Spinach,	12	3	–	6
Tomatoes,	56	14	1	12
Turnips,	55	13¾	1	11½
Wheat,	60	15	1	14

Weights

Flour,	196	pounds.
Potatoes,	165	pounds.
Potatoes, sweet,	150	pounds.
Liquid barrel,[1]	31½	gallons.
Hogshead,	2	barrels.

[1] The Massachusetts statutes provide that "in barrels and fractional parts of barrels containing malt beverages a variation or tolerance of six per cent. shall be permitted."

Importance of Saving Paper and Rags.

Save your old paper and rags! By so doing, according to the United States Department of Commerce, you not only will be enriching yourself to a certain extent, but will be aiding paper manufacturers to solve what promises to become a very serious problem — the shortage of raw materials.

The reason for saving and selling waste paper is not solely that of getting money for it from the junkmen; it is to provide raw material that will keep the paper factories going, and that will consequently provide paper for newspapers and books, and for wrapping bundles and packing goods.

The department is sending broadcast letters to business firms urging them to conserve their old paper. Something like 15,000 tons of paper are manufactured every day in the United States, and a large proportion of this, after being used, is thrown away and burned, with the result that just so much raw material must be obtained.

Most of this paper can be used again in the manufacture of a slightly inferior grade.

The following quaint notice tells, in a simple way, of the beginning in 1801 of the celebrated Crane paper mills at Dalton. It applies to these days as well as one hundred and fifteen years ago, for we are much in need of rags with which to make paper. The paragraph reads: —

Americans!

Encourage your own Manufactories, and they will improve.

Ladies, ſave your Rags.

As the Subſcribers have it in contemplation to erect a PAPER-MILL in Dalton, the enſuing ſpring; and the buſineſs being very beneficial to the community at large, they flatter themſelves that they shall meet with due encouragement. And that every woman, who has the good of her country, and the intereſt of her own family at heart will patronize them by ſaving their rags, and ſending them to their Manufactory, or to the neareſt Storekeeper — for which the Subſcribers will give a generous price.

HENRY WISWALL,
ZENAS CRANE,
JOHN WILLARD.

Worceſter, Feb. 8, 1801.

IMPORTANCE OF MEASUREMENTS IN HOUSEKEEPING.

Measurements of Household Products and Processes.

Improved precision has slowly evolved from the guesswork of earlier times. For example, terms like the "pinch of salt," "speck of pepper," "handful of rice," "sweeten to taste" (units of vague magnitude) have gradually been replaced by definite amounts, specified and measured. A process is uncertain of success unless the effect of all the factors entering into it is known. In factories, where food is prepared on a large scale, temperatures are carefully measured or determined automatically, and amounts and times are accurately controlled. These methods, which make for efficiency and economy, are being used more and more in the household.

Such measurements as require costly or delicate apparatus cannot yet be expected to be common in the home; and some still think that the measurement of temperature of rooms, of ovens and sirups, and the weighing of purchases, etc., are unimportant. However, scales, thermometers and a few other simple measuring appliances can be obtained for a small expenditure, and this circular will attempt to show some of the advantages of their use. Measuring instruments for household use which are automatic, or which may easily be operated without special training, are becoming more and more available.

Household Measuring Appliances.

A large variety of measuring appliances are used in connection with the household work. (See Fig. 3.)

Kitchen Measuring Appliances.

In the kitchen more accurate weights and measures are gradually coming into common use as the units used are becoming better defined. Domestic science departments of schools and colleges are largely responsible for this advance.

The basis of the kitchen system of weights and measures is the standard cup, a measure holding 8 fluid ounces — that is, one-half liquid pint — and used to measure either dry or liquid commodities. One of these cups, subdivided into thirds, fourths, or both, should

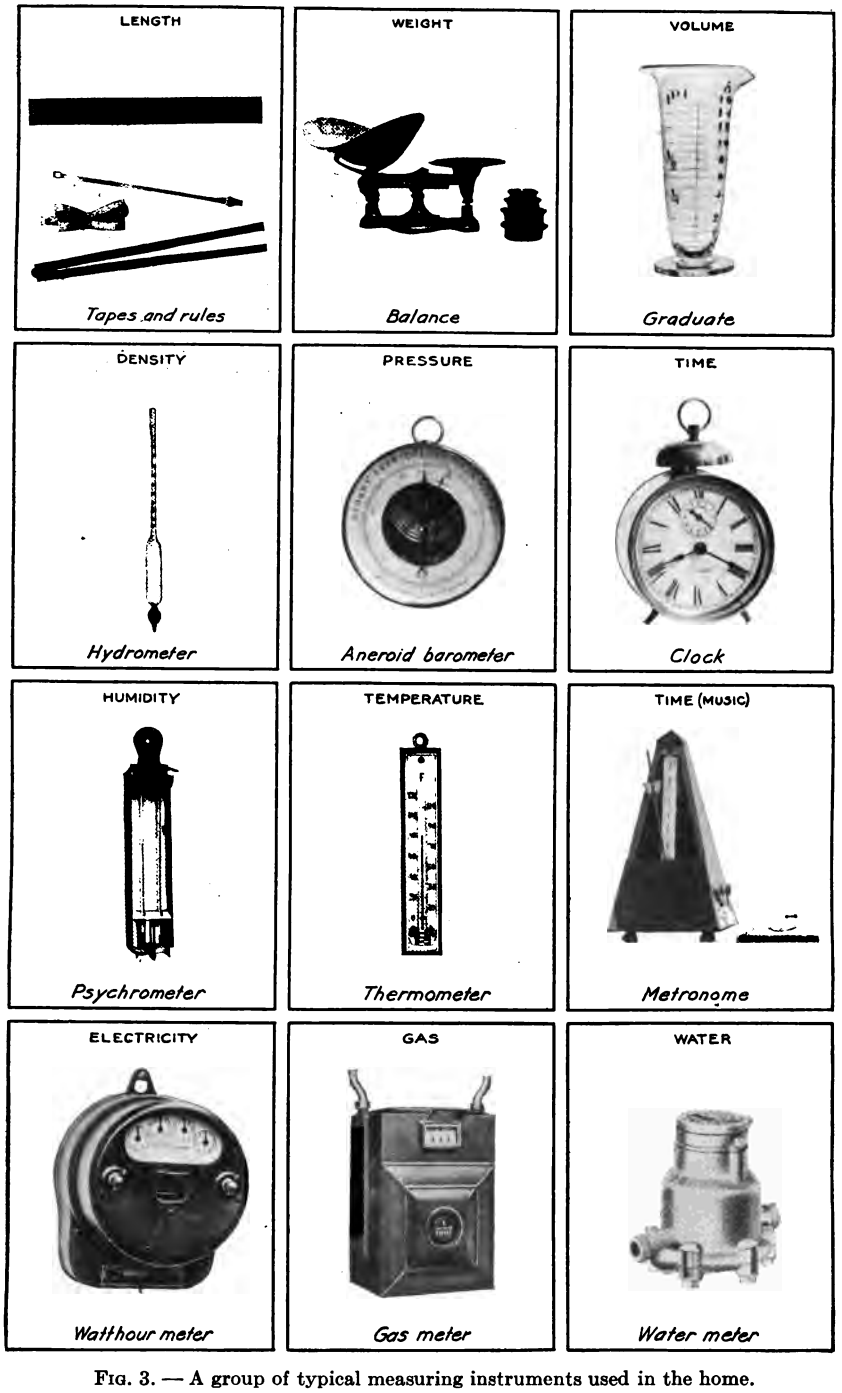


FIG. 3. — A group of typical measuring instruments used in the home.

The efficient management of the home requires a set of suitable measuring appliances. The group shown above emphasizes the variety of measurements needed by the modern household. The pictures do not show true relative sizes nor is the list complete. Other types are found in many modern houses and other forms of those shown above are recommended for special purposes.

be procured, since the ordinary china cups vary greatly in size. A special set of spoon measures (from one-fourth teaspoonful up)

FIG. 4. — Measures used in the kitchen.

For cooking and other purposes in the kitchen the following capacity measures are useful: a 4-ounce glass graduate, a teaspoon measure (with half and quarter fractions) and a cup measure (of glass or metal). The cup measures shown have the same capacity (8 fluid ounces), although the thinner walls of the aluminum measure make it smaller in appearance.

will be found convenient, since ordinary spoons also vary in size. Moreover, neither the ordinary cup nor spoon is adapted to measuring fractions of their capacity.

Equivalents of Capacity Units used in the Kitchen.

The measures of capacity used in the kitchen are based upon the standard cup, as follows: —

3	teaspoonfuls	= 1	tablespoonful = 4 drams.
4	tablespoonfuls	= ¼	cupful = 2 fluid ounces.
½	cupful	= 1	gill = 4 fluid ounces.
2	gills	= 1	cupful = 8 fluid ounces.
1	cupful	= 8	fluid ounces.
2	cupfuls	= 16	fluid ounces.
16	fluid ounces	= 1	pint.
4	cupfuls	= 1	quart.

In the above table all measures are level full. The equivalents given will permit the use of the large glass graduate for measuring liquids in cooking.

In Table 1 are given equivalents of units commonly used in cooking and for other household purposes.

TABLE 1. — *Equivalents of the Common Capacity Units used in the Kitchen.*

UNITS.	Fluid Drams.	Teaspoonfuls.	Tablespoonfuls.	Fluid Ounces.	¼ Cupfuls.	Gills (½ Cupfuls).	Cupfuls.	Liquid Pints.	Liquid Quarts.	Cubic Centimeters.	Liters.	UNITS.
1 fluid dram equals	1	¾	¼	⅛	1/16	1/32	1/64	1/128	1/256	3.7	0.004	Equals 1 fluid dram.
1 teaspoonful equals	1⅓	1	⅓	⅙	1/12	1/24	1/48	1/96	1/192	4.9	0.005	Equals 1 teaspoonful.
1 tablespoonful equals	4	3	1	½	¼	⅛	1/16	1/32	1/64	15	0.015	Equals 1 tablespoonful.
1 fluid ounce equals	8	6	2	1	½	¼	⅛	1/16	1/32	30	0.030	Equals 1 fluid ounce.
¼ cupful equals	16	12	4	2	1	½	¼	⅛	1/16	59	0.059	Equals ¼ cupful.
1 gill (½ cupful) equals	32	24	8	4	2	1	½	¼	⅛	118	0.118	Equals 1 gill (½ cupful).
1 cupful equals	64	48	16	8	4	2	1	½	¼	237	0.237	Equals 1 cupful.
1 liquid pint equals	128	96	32	16	8	4	2	1	½	473	0.473	Equals 1 liquid pint.
1 liquid quart equals	256	192	64	32	16	8	4	2	1	946	0.946	Equals 1 liquid quart.
1 cubic centimeter equals	0.27	0.20	0.068	0.034	0.017	0.0084	0.0042	0.0021	0.0011	1	1/1000	Equals 1 cubic centimeter.
1 liter equals	270	203	67.6	33.8	16.9	8.45	4.23	2.11	1.06	1000	1	Equals 1 liter.

HEAT AND HEATING APPLIANCES.

What is meant by Temperature and by Heat.

The terms "heat" and "temperature," while often confused, have very different meanings. Temperature is familiar to all. Certain so-called *fixed* temperatures serve as starting points (reference points) for measurement. The most familiar of these is the *temperature of the body*, which is usually about 98½° F. Objects about us are said to be "warm," "hot," "cool" or "cold" compared with this temperature, — not a very accurate or reliable standard, to be sure, but one which serves well enough for some purposes. This standard is, however, of little use for estimating temperatures of objects of very different materials, *e.g.*, iron and wool. The better heat conductors, like iron, take heat from the hand much more rapidly than do poor conductors, like wool, and therefore feel colder (or warmer), even though at the same temperature. A bare floor feels much colder than a rug, although they are probably at the same temperature.

Neither is this standard of much service in estimating temperatures colder than that of melting ice or for those as hot as boiling water. There is often need to measure temperatures lower than that of ice and higher than that of steam, and with more certainty than can be done with the hand; therefore various kinds of thermometers are used, and temperatures are expressed by definite scales on which the *melting point of ice* and the *boiling point of water* have certain fixed numbers. On the Fahrenheit scale these are 32° and 212°; on the centigrade scale, 0° and 100°, respectively.

A warm object differs from the *same* object when cold; it feels different to the hand; it is generally somewhat larger; and it will warm other objects placed near it. Thus, *temperature is a quality* or condition of objects and is measurable by means of thermometers. A certain definite amount of *heat* must be supplied to any object to warm it from one temperature to another, and this amount of heat must escape before the object can cool back to the former temperature. Heat is not measured directly by means of thermometers. It is only the effect of heat which is measured. When a pound weight falls a foot to the ground a foot-pound of work is lost and a definite amount of heat is produced. When a pound of coal or a cubic foot of gas is burned a definite amount of heat is produced, which depends upon the quality of the coal or of the gas. Therefore *heat is a measurable quantity* and can be ex-

pressed in "heat units." Thus, the "British thermal unit" (Btu) is that amount of heat which will warm 1 pound of water 1 degree Fahrenheit. The "calorie" is that amount of heat which will warm 1 gram of water 1 degree centigrade. If 1 Btu is supplied to 2 pounds of water the temperature will rise only one-half degree Fahrenheit, etc. It is convenient to remember that 180 Btu will heat 1 pound (about a pint) of ice-cold water to the boiling point, or 100 kilo-calories (100,000 calories) will heat a kilogram (a little over a quart) of ice-cold water to the boiling point.

Thermometers.

The familiar mercurial thermometer for household use is made somewhat as follows: a glass bulb is blown or sealed on to the end of a fine-bore glass tube or "stem." The bulb and part of the stem are then filled with mercury (quicksilver) and the top sealed after removing the air. This blank thermometer is placed in water at different known temperatures and the positions of the top of the mercury marked. A scale is then made, either on a separate strip of metal or on the glass, such that for a Fahrenheit thermometer the ice point will be 32°, the boiling point 212°, and the distance between will be divided into 180 equal degrees. On the centigrade scale the ice point is 0° and the boiling point 100°.

Heating Value of Fuels.

The heat required for heating, cooking and other purposes may come from any one of several sources, and the one chosen should depend upon the cost and convenience of the heat supplied from these different sources. Table 2 gives the approximate amount of heat produced by burning several different kinds of fuel, also the number of gallons of water which could be heated from 32° to 212° F. (0° to 100° C.) for 1 cent, *if no heat were lost.*

These figures apply to the cost of the heat actually supplied to the water, but the true cost of any operation, like heating a kettle of water or baking a loaf of bread, will depend also upon what proportion of the heat is utilized, and this again depends upon the nature of the fuel. For instance, a coal fire must be kept burning for a long time in a stove of considerable size, so that much of the heat from the fuel is used in heating the stove and still more is radiated from the heated surface of the stove, while perhaps only a very little heat is actually used. A gas burner, on the other hand,

may be lighted and turned out quickly, and there is no large amount of metal to heat, so that much less heat is wasted. For this reason gas, which costs six times as much as hard coal for each heat unit, may still be cheaper than coal to use when heat is needed for only a short time.

TABLE 2. — *Comparison of Fuels.*

MATERIAL.	Heating Value.	Price.	Gallons of Water which could be heated from 32° to 212° F for 1 Cent.
	Btu per Pound.		
Softwood,	8,000	$4 per cord (2 tons),	53.00
Hardwood,	8,000	$4 per cord (3 tons),	80.00
Soft coal,	13,000	$4 per ton,	43.00
Hard coal,	13,000	$7 per ton,	25.00
Coke,	12,000	$5 per ton,	32.00
Charcoal,	16,000	$25 per ton,	8.50
Fuel oil,	18,000	$1.25 per barrel (50 gallons),	36.00
Kerosene,	18,000	$0.10 per gallon,	8.30
Alcohol,	12,000	$0.50 per gallon,	1.00
Gasoline,	19,000	$0.20 per gallon,	3.50
	Btu per Cubic Foot.		
Natural gas,	1,000	$0.40 per 1,000 cubic feet,	17.00
Manufactured gas,	600	$1.00 per 1,000 cubic feet,	4.20
	Btu per Kilowatt Hour.		
Electricity,	3,400	$0.10 per kilowatt hour,	0.23
	Btu per Pound.		
Ice (to absorb heat),	160	$0.35 per hundredweight,	0.32[1]

[1] Water from 212° F. to 32° F., gallons for 1 cent.

NOTE. — Ice in melting absorbs 143 Btu per pound, but the ice water thus formed also absorbs from 15 to 20 Btu additional before it leaves the refrigerator, making a total of about 160 Btu.

Hard coal when burned gives out about 13,000 Btu per pound, and if it costs $7 per ton, the last column shows that 25 gallons of water can be heated from 32° to 212° by burning 1 cent's worth of coal, provided none of the heat were lost; or kerosene supplies 18,000 Btu per pound, and 1 cent's worth of it at 10 cents per gallon would heat 8.3 gallons of water from 32° to 212° F. The Btu, or British thermal unit, is a unit chosen for comparison, it being the quantity of heat necessary to raise 1 pound of water through 1 degree Fahrenheit.

All fuels in burning require a certain amount of air. If enough air is not supplied, part of the fuel will not burn; if too much air is supplied, an unnecessary amount of heat is carried away in the smoke.

The economy of different fuels depends upon how completely they are burned. It is easy to see that coal is usually not entirely burned, since unburned pieces are found in the ashes. That gas, also, is not

always entirely burned may not be so well known, because unburned gas is not visible. But partly burned gas is always dangerous, containing more or less of the poisonous gas carbon monoxide. This gas is produced when a burner "strikes back" or burns in the tube instead of from the proper openings. Some of it is also produced when an ordinary gas, oil or gasoline flame plays upon a cold surface, as the bottom of a kettle of water. Partly burned gas can almost always be detected by a pungent odor. This is not the odor of carbon monoxide, but some of the latter is almost always present when there is such an odor. On account of the danger of this gas (carbon monoxide) all gas water heaters, and preferably gas and gasoline stoves as well, should be supplied with flues to carry off dangerous or partly burned gases.

Gas-stove burners should be adjusted so that the blue-green central part of the flame is about half the height of the whole flame. If the flame is very long and is bright yellow in parts, too little air is being admitted; if short and inclined to make a slight roaring noise, there is too much air. In the latter case the flame is liable to "strike back," under which condition much carbon monoxide is formed. In all gas burners the various openings should be kept clean. The amount of air supplied to gas burners is usually adjusted by means of a small damper or slide to be found at the base of the burner.

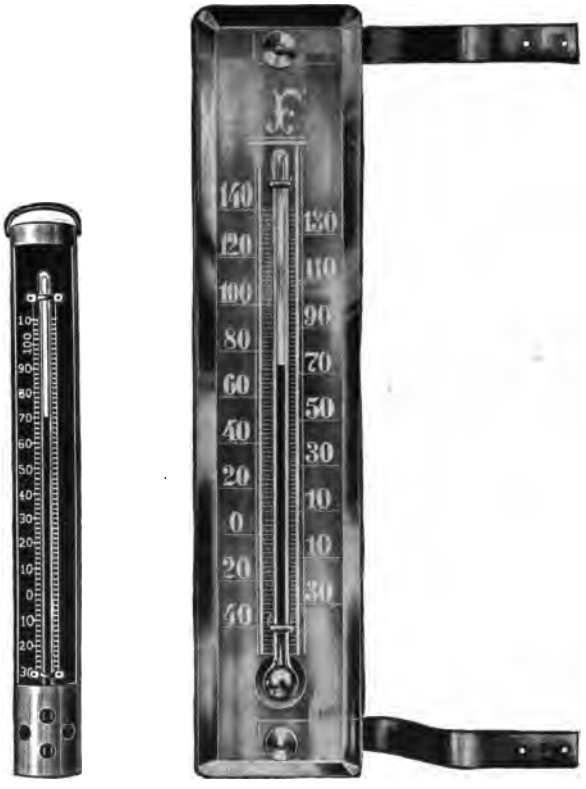
FIG. 5. — A thermometer for measuring the temperature of rooms.

Such thermometers should be hung about 4 feet from the floor and away from cold outside walls, windows or heating appliances.

Radiation of Heat.

Hot objects, like stoves and steam pipes, lose much of their heat by radiation, and the blacker the object the more it will lose; hence, stoves and steam pipes should be blacked if they are intended to give out heat, but hot-air pipes, cooking utensils, etc., should be bright (for instance, tinned or nickeled) in order to lose as little heat as possible. A stove nickel plated all over will give out only about half as much heat as the same stove at the same temperature if black. Brightly tinned hot-air furnace pipes often lose less heat bare than they do when covered with one or two layers of asbestos paper,

since the asbestos paper radiates heat so much more readily than the bright tin as to more than balance the insulating effect of the thin asbestos covering. Of course, if the pipes were black to begin with, the covering would be useful, and if the insulating material



FIGS. 6 AND 7. — Thermometers for use out of doors.

Such thermometers should be hung about 4 feet from the ground in the shade and not against the side of a building.

were thick enough (say $\frac{3}{8}$ inch or more) it would save heat even on bright tin pipes.

A bright nickel or aluminum kettle will cool very much more slowly than a black kettle. On a coal or wood stove or directly over a coal or wood fire a kettle is heated largely by heat radiated from the stove or fire, therefore if the bottom is black the kettle will heat more rapidly than if bright. Over a gas, gasoline or similar blue

flame the condition of the bottom will not make so much difference, since here most of the heat is received by contact with the hot gases. The best kettle for general use is therefore one with the bottom black and the remainder polished, but for use on a gas stove it makes little difference whether the bottom is black or not.

Regulation of Stoves, Ranges and Other Heating Appliances.

The air which enters cold below the fire in any stove or furnace passes up through the fire, producing combustion and absorbing the heat produced, except that which escapes through the sides of the

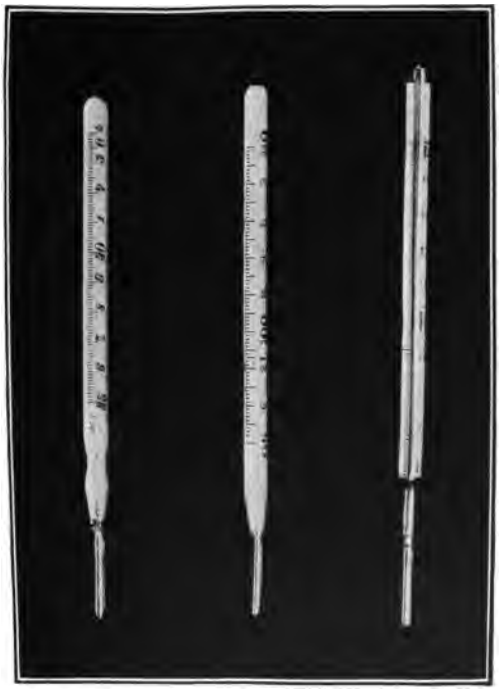


FIG. 8. — Types of clinical thermometers.

These thermometers are used by physicians and nurses, and one should be owned by every family.

fire box. This heated air may then be utilized for heating in one of several ways, as by letting it pass around water tubes or through flues in a boiler, around air flues in hot-air furnaces, around the oven in a cooking range, or through a heating drum and length of pipe in the common heating stove. Whatever heat is left in the

flue gas when it enters the chimney is useless except for increasing the draft. It is therefore important to utilize as large a proportion of the heat as possible before the gases reach the chimney. This can best be done by (1) having the gases as hot as possible, (2) allowing them to pass out as slowly as practicable, and (3) bringing them into the best possible contact with the flues, oven sides or other heating surfaces.

Good contact between flue gases and the heating flues can only be obtained in any given stove or furnace by keeping the flues clean and free from soot and ashes. This is very much more important than most persons realize.

The gases will be hotter and will also pass more slowly the less their *amount;* therefore no more air should be admitted to the stove or furnace than is necessary. This applies particularly to air which might be admitted over the fire by opening the fire door or a draft in it, except under the following conditions: —

When combustible gases are produced by the heating of fuels such as soft coal or wood, it is sometimes necessary to admit air over the fire so as to permit the gases to burn. Therefore with such fuels some air should be admitted through the fire door, or in some other manner immediately over the fire, so long as a bright flame is produced.

With hard coal, coke and charcoal, as well as with wood or soft coal, after the flame has burned out no air should be admitted over the fire.

In most cooking ranges and in some heating stoves and furnaces there is a damper which permits smoke from the firebox to pass directly to the chimney without passing through the heating flues. One should learn how any such damper operates and keep it closed, except possibly when first starting up the fire. Opening this damper will often make the fire burn more briskly, but most of the extra heat thus produced is usually lost up the chimney. In summer, however, when extra heat is not desired, this damper may be left open to allow heat to escape up the chimney.

This discussion suggests a few general rules for controlling heating and cooking fires.

1. To increase the amount of heat, open drafts which let air into the ash pit, and with *soft coal* and *wood* when fresh fuel has been added admit some air by draft immediately over the fire to help

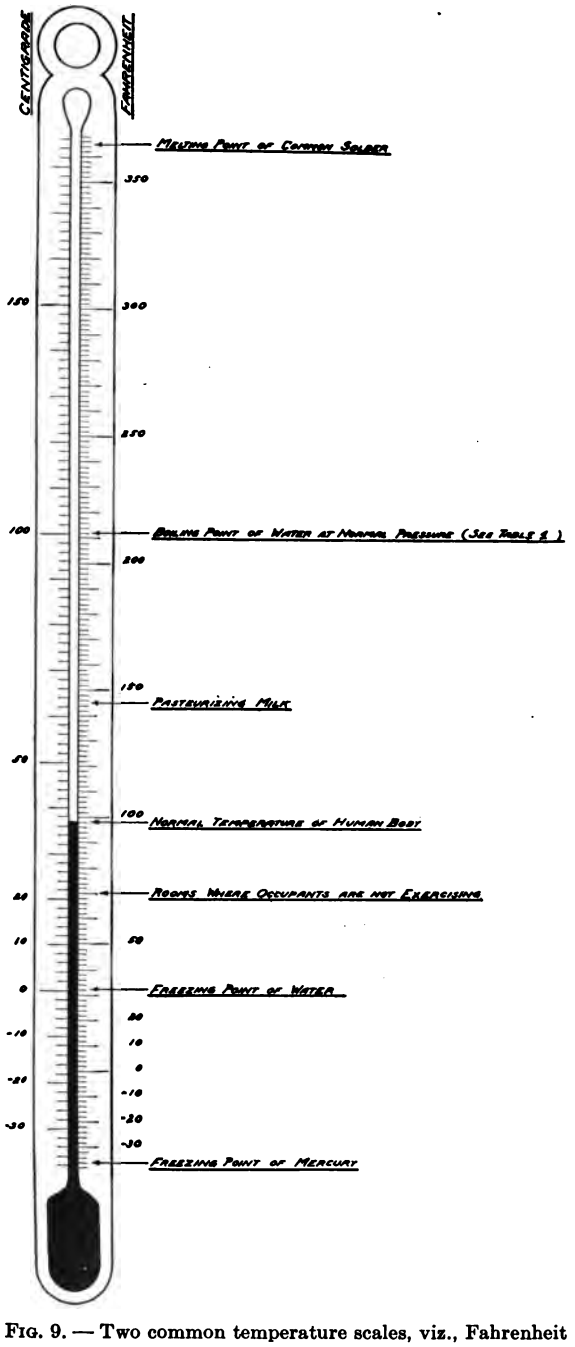


FIG. 9. — Two common temperature scales, viz., Fahrenheit and centigrade.

On the centigrade scale the freezing point and normal boiling point of water are, respectively, 0° and 100°; on the Fahrenheit scale these points are 32° and 212°; thus 1° centigrade is equal to 1.8° Fahrenheit.

burn the combustible gases coming from the fresh fuel. For all fires burning without flame keep this draft closed.

2. To decrease the amount of heat close all drafts tight (being sure that ash-pit door and drafts particularly are tight and that the ash pit itself is free from air leaks), and if this is not sufficient open a check draft in the smoke pipe (*never the one in the fire door* or the door itself, as this practice is extremely wasteful of fuel).

3. To *insure economy* of fuel see that all flues and surfaces which the hot gases pass on their way to the chimney are cleaned every two or three weeks.

4. Be very careful in the use of the damper which closes off the smoke pipe, as such a damper is dangerous if closed too tightly and can be left wide open or taken out entirely provided the ash pit is tight and the above directions are followed.

5. Keep the direct draft in a cooking stove or range closed except in hot weather, or when starting a fire.

Coal.

After coal has been delivered, its weight can be checked only roughly. If shortages are suspected, the details should be reported to the local sealer, who should be able to reweigh the coal furnished, or at any rate check the weight of the next delivery, if notified when this will occur. A weight certificate should be furnished by the seller, showing the net weight of the coal claimed to be delivered. The quantity of coal delivered may be roughly checked by ascertaining the amount in the bin, provided this is empty before the new coal is put in. If the bin is rectangular, with a level bottom and vertical sides, this is accomplished as follows: measure the exact length and the exact width of the bin in feet and fractions of a foot. Then level off the top of the coal and measure its depth in the same unit. The product of the length and width of the bin, multiplied by the average depth of the coal, will be the number of *cubic feet of coal* in the bin. Multiply this result by the *weight of the coal per cubic foot,* as given below, and the product will be the approximate number of *pounds* of coal in the bin. This evidence alone would not be accepted by a court, but it may be used to detect gross shortages and as a basis of complaint to the local sealer.

Average Weight of Anthracite Coal in Pounds per Cubic Foot.

The average weight per cubic foot of anthracite (hard) coal varies with the size into which it is broken, and with the kind of coal or the vein from which the coal comes. The latter variation is nearly 10 per cent., but the figures given below are the average of several different kinds and will probably represent the average coal purchased within 2 or 3 per cent. Red-ash coal is somewhat lighter than that giving white ashes, hence, two sets of values are given below: —

Average Weight of Anthracite Coal in Pounds per Cubic Foot.

Size.	White Ash.	Red Ash.
Egg,	57.0	53.0
Stove,	56.5	52.5
Nut,	55.5	52.0
Pea,	53.5	51.0
Buckwheat,	53.0	50.5

The weight of bituminous (common soft) coal varies even more than that of anthracite, according to the locality from which the coal comes, and about the best figure that can be used is 47 to 55 pounds per cubic foot.

Example. — Find the number of pounds of a white ash anthracite coal of nut size in a bin 6 feet long and 4 feet 3 inches wide, with vertical sides, the coal filling the bin to an average depth of 2 feet 6 inches. Then, following directions and taking from the above table the weight of a cubic foot of white ash nut coal as 55.5 pounds —

Area of bottom = 6 feet by 4.25 feet = 25.5 square feet.
Volume of coal = 25.5 square feet by 2.5 feet = 63.75 cubic feet.
Weight of coal = 63.75 by 55.5 = 3,538 pounds.

If in this case 2 tons of coal were charged for, and the measurements were accurately made, the purchaser may be fairly certain that full weight has not been delivered.

REFRIGERATION.

Refrigerators and Other Cooling Devices.

The ordinary household refrigerator, even of the best make, is by no means as effective in the saving of ice as might be desired. The principles of operation are, briefly, as follows: a block of ice is placed in a compartment near the top of the refrigerator and having one or more openings at both top and bottom. The air next the ice becomes cool and sinks through the bottom openings of the ice

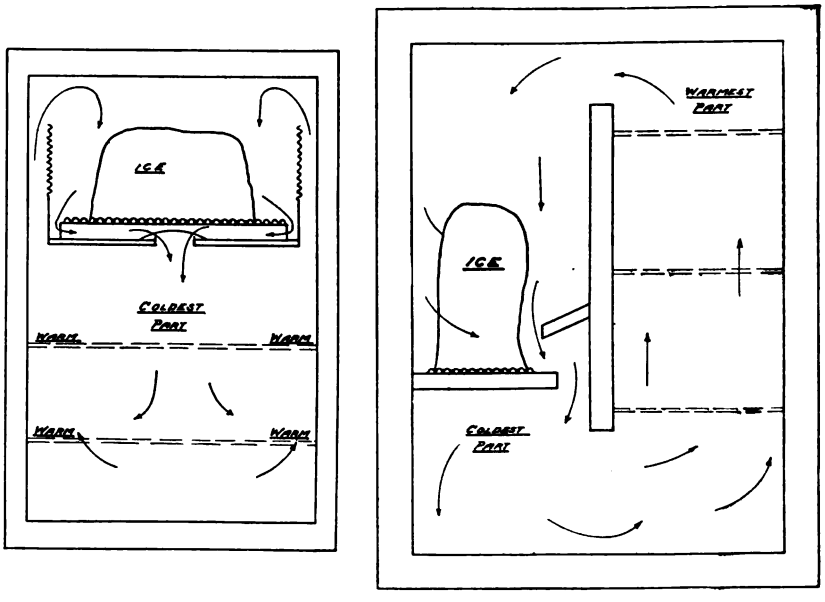


FIG. 10. — Diagram showing the circulation of air in two usual types of refrigerators.

Air entering the ice chamber is freed from odors, cooled, and sinks through the bottom openings, drawing in the warmer air at the top. Butter, milk and meats should occupy the coolest space, while food having a strong odor should be placed where the air is just about to enter the ice chamber.

chamber into the main part of the refrigerator, while warmer air from the upper part of the refrigerator enters the top of the ice chamber and is there cooled. There is thus a continuous circulation of air past the ice and through the food chamber. (See Fig. 10.) This circulation is important because it distributes the cooled air to all parts of the refrigerator, and also because on passing the ice the air loses some of the moisture and the odors which it has taken up

from the food, especially that which is not yet cold. Therefore, anything which retards this circulation or stops up the openings to the ice chamber should be avoided.

Slow melting of the ice does not necessarily indicate a good refrigerator. Unless the ice melts it can absorb no heat and is therefore of no use in a refrigerator. Protecting the ice in a refrigerator by covering it up is a good way to save ice but a *poor way to save food.* The only proper way to use less ice is by using a refrigerator with better insulated walls, and by opening the doors as seldom and for as short times as possible.

It has been found (Bulletin No. 98 of United States Department of Agriculture) that in milk kept at 60° about fifteen times as many bacteria will develop in one day as in milk kept at 50° F., and much the same is true of many other foods. *It is important, therefore, to find the coldest places in a refrigerator* (usually near where the air leaves the ice chamber) *and use these places for foods such as milk and meats, which need to be kept as cool as possible to prevent spoiling.*

The Vacuum or "Thermos" Bottle.

Another very useful device for keeping things cool, or hot, is the vacuum or "thermos" bottle. This is made up simply of one glass bottle within another with a space of from one-fourth to one-half inch between them, free from air, and the surfaces silver plated on the vacuum side. Most of the heat which leaves or enters a hot or a cold object is carried by the circulation of air, called convection, and some also by direct radiation. Thus, when air is absent there is no convection, and when the surfaces are good reflectors, like bright silver, there is very little radiation, and very little heat can enter or leave the inside of the thermos bottle. A bottle covered with a very thick layer of ground cork, feathers, cotton, wool or other such material might retain heat about as well as a thermos bottle, but would be less convenient to handle, as the insulating layer would need to be 2 or 3 inches thick instead of a quarter to half an inch.

The refrigerator and thermos bottle are by no means the only domestic cooling devices. There are several small refrigerating machines on the market suitable for use in cooling the ordinary household refrigerator. Descriptions of these would be out of place

here, as they can be found in trade catalogues. Such machines all resemble the large mechanical refrigerating machines used for making artificial ice and for cooling cold-storage houses.

Cooling by Evaporation.

The natives of dry, hot climates have for centuries used cooling devices based on the cooling produced by the evaporation of water. As has been said before, to boil away or evaporate a pint of water requires about 1,000 Btu of heat, whether the water boils in the ordinary way or evaporates into the air at ordinary temperatures (in fact, it requires more heat to evaporate water at lower temperature). If the air is dry evaporation is quite rapid even when water is cool. Thus, when water is placed in a slightly porous unglazed earthen vessel a small amount continually filters to the outside and evaporates, keeping the contents several degrees cooler than the surrounding air. This device in various forms has been used for hundreds and perhaps thousands of years.

Ice.

A cubic foot of ice (12 by 12 by 12 inches) weighs 57 pounds 8 ounces. A cubic inch of ice weighs .532 ounce. A cake 22 by 22 and 1 inch thick weighs 16 pounds, and for each additional inch in thickness the weight will increase 16 pounds. A cake 22 by 32 and 1 inch thick weighs 23 pounds, and for each additional inch in thickness the weight will increase 23 pounds.

The following table shows the weight of pieces of ice of various sizes. For other sizes multiply length by width by height (in cubic inches), and that product by .532, and divide the result by 16. This will give the weight of ice in pounds. The approximate weight of a given block of ice, in pounds, may be more quickly, though possibly less accurately, determined by using this formula: cubic inches ÷ 30 = pounds.

Weight of Blocks of Ice of Various Sizes.

Inches.	Pounds.	Inches.	Pounds.
7× 7× 7,	11	9×12×15,	54
8× 8× 8,	17	11×11×14,	56
8× 9×10,	24	12×12×12,	58
9× 9× 9,	24	8×22×10,	59
9× 9×10,	27	10×12×15,	60
8×10×11,	29	12×12×13,	62
10×10×10,	33	8×22×11,	64
8×11×12,	35	12×12×14,	67
9×10×12,	36	8×22×12,	70
10×10×11,	37	12×12×15,	72
8×11×13,	38	12×13×14,	73
8×12×12,	38	13×13×13,	73
10×10×12,	40	8×22×13,	76
11×10×11,	40	13×13×14,	79
9×10×14,	42	13×13×15,	84
10×11×12,	44	11×24×10,	88
11×11×11,	44	13×14×15,	91
11×11×12,	48	14×14×14,	91
11×11×13,	52	10×16×18,	96
11×12×12,	53	12×14×18,	101

Note. — The above table was compiled by the Natural Ice Association of America.

LIGHT.

Sources and Cost of Light.

For the production of light a great variety of lamps are available and in some kinds remarkable improvements have been made in the last few years. These improvements have made it possible in many cases either to improve the lighting of the home without increasing the cost or to reduce the cost. The cost of lighting by any method depends to some extent on local conditions, and the statements of cost given below will apply only approximately in any particular case. The cost will naturally depend on the candlepower of lamps used and the time the lamps burn. In order to make comparisons between different kinds of lamps it is convenient to consider a definite amount of lighting, which is obtained by multiplying the candlepower of the lamps burned by the number of hours they burn. For example, 1,000 candle-hours of lighting may be obtained

by burning a 10-candle lamp 100 hours or a 50-candle lamp 20 hours, but if the lamps are of the same kind the cost will be about the same. Calculations of the cost of producing 1,000 candle-hours by different lamps are sometimes useful in choosing between lamps, but of course it does not necessarily follow that the lamp for which

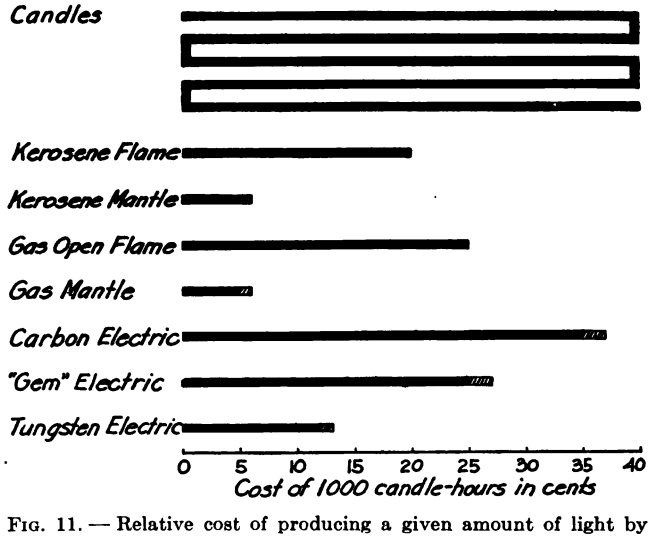


FIG. 11. — Relative cost of producing a given amount of light by various illuminants at usual prices.

Costs are based on the following prices: candles, 12 cents per pound; kerosene, 15 cents per gallon; gas, $1 per 1,000 cubic feet; electricity, 10 cents per kilowatt hour. The solid lines represent cost of fuel or of current, the shaded parts the cost of the mantles and bulbs. Where prices are different from those given above, costs will be correspondingly different.

this cost is lowest is most economical for household use. Data concerning relative costs of producing light by common methods usually employed in the house are given in Fig. 11.

The Gas Meter Index and How to read it.

Fig. 12 illustrates the index of an ordinary gas meter, which is similar to that of an electric meter or a water meter. The smaller top dial, which is marked "Two feet" inside of the circle, is generally called the "testing circle" or "proving head," and is used principally in testing the meter. One revolution of the hand of the testing circle indicates that 2 cubic feet of gas have passed through the meter. In some meters one revolution of the hand of the testing

circle represents more or less than 2 cubic feet of gas, and the testing circles are correspondingly marked. The indication of the hand of the testing circle is ignored in the ordinary reading of the meter.

Of the large dials the first one at the right is usually marked "1 thousand." This means that during one complete *revolution* of the hand 1,000 cubic feet of gas has passed through the meter. This dial is divided into 10 equal parts, so that the passage of the hand over each part indicates the passage of one-tenth of 1,000

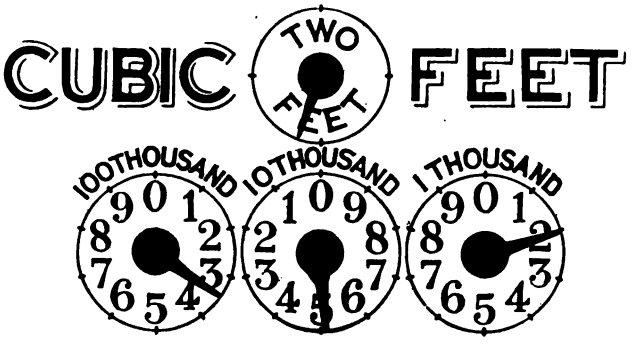


FIG. 12. — The index of a gas meter.

Each dial is marked with the volume of gas passed per revolution. The smaller top dial, which is marked "Two feet" inside of the circle, is generally called the "testing circle" or "proving head" and is used principally in testing the meter.

cubic feet, or 100 cubic feet. For most meters it may be said of the other dials that the complete revolution of each hand indicates the passage of ten times as much gas as one revolution of the hand of the dial of next lower denomination (usually the one to the right). The figure representing the number of cubic feet discharged during one revolution of the hand appears over each dial. Thus if the first dial is marked "1 thousand," the second dial will be marked "10 thousand," the third "100 thousand," and so on.

The reading of the index, as illustrated in Fig. 12, is as follows: —

	Cubic Feet.
Reading of " 1 thousand" dial,	200
Reading of " 10 thousand " dial,	5,000
Reading of " 100 thousand" dial,	30,000
Complete reading of the meter,	35,200

Cost of Gas consumed per Hour.

Numerals refer to Cost per Hour in Mills (Tenths of a Cent).

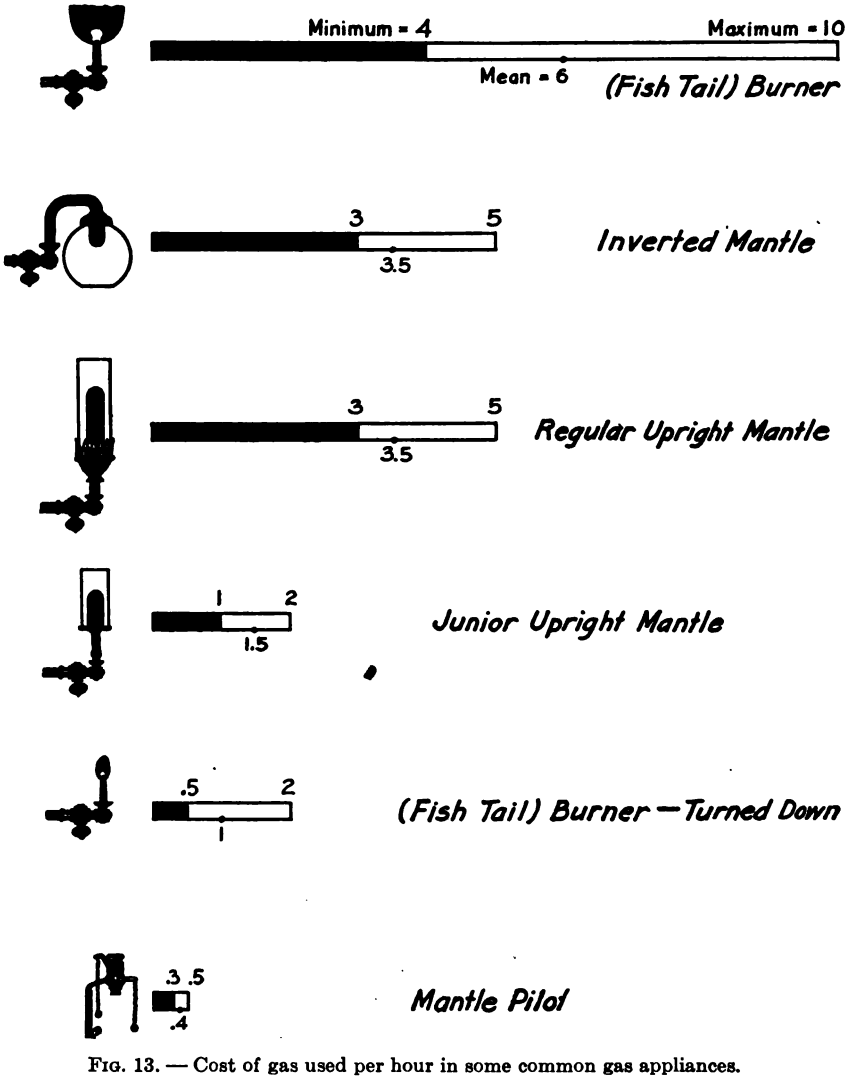


FIG. 13. — Cost of gas used per hour in some common gas appliances.

The cost per hour is calculated on the basis of gas at $1 per 1,000 cubic feet. The large difference between maximum and minimum costs is due to difference in size of burners and difference in the pressure of the gas supply. The mean value represents the cost under average conditions.

For a water heater of ordinary household size the gas would cost from 3 to 8 cents per hour. For larger automatic water heaters gas would cost from 10 to 25 cents per hour for the period that the heater is in operation. The pilot-flame gas for these heaters would amount to one-tenth of a cent per hour. Room heaters require 5 to 12 cents worth of gas per hour.

Since a match costs only one-tenth mill or less, it is usually economical to turn off the gas when not in use, except for short intervals.

Reading the Watt Hour Meter Dials.

A view of the dials of a modern [1] electric meter is given in Fig. 14. The method of reading is similar to that of reading the dials of a gas meter. The reading in Fig. 14 is 538 kilowatt hours. In taking down these figures one should read the dials from right to left; that

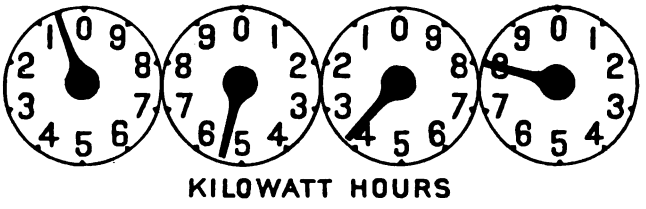


FIG. 14. — Dial of a watt hour meter.

In this dial the hands are correctly set on their shafts. The reading is 538 kilowatt hours.

is, in the reverse of the usual order of writing numbers. The pointer on the dial at the extreme right points to 8; the number 8 is written down as the figure in the units place. The index of the next dial to the left has passed the 3, but has not reached the 4, as shown by

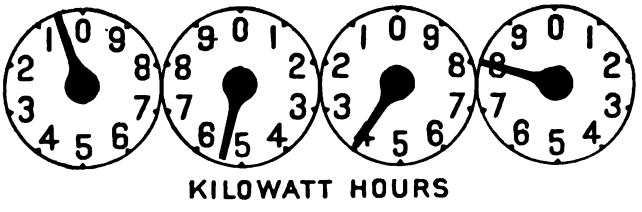


FIG. 15. — Dial of a watt hour meter.

In this dial the hand on the second circle from the right is slightly in advance of its proper position on its shaft. The reading is the same as in Fig. 14, namely, 538 kilowatt hours, although at a glance it might be incorrectly read as 548 kilowatt hours.

the fact that the units dial reads 8; the figure 3 is accordingly written in the tens place. The index of the third dial has passed the 5, and this figure is to be written in the hundreds place, giving 538 kilowatt hours as the reading of the meter, since the index of the dial at the extreme left has not reached the figure 1.

[1] There are older types of meters in service which have five dials, the one farthest to the right having 10 divisions, each equal to one-tenth of a kilowatt hour, instead of 1 kilowatt hour per division as in the standard dial herein described.

Generally speaking, the electric meter is a commercially accurate measuring device. It requires cleaning at certain intervals, just as a watch does, and, like the watch, if neglected it usually tends to run slow. Under some circumstances a meter may be fast; that is it may record in excess of the actual energy that has passed through it. Properly managed electric light companies do not want their meters to run either fast or slow, and they have a force of men whose work consists of testing, cleaning and readjusting meters.

Causes of High Bills for Electricity.

When the bill for electric current seems unduly high, the meter is often the first thing suspected. In reality it is usually the last thing to blame. Some of the reasons for higher bills are as follows: —

1. Cloudy or rainy weather, requiring use of light in daylight hours.

2. Additional lamps may have been installed, or small lamps may have been replaced by larger ones.

3. Old dim lamps may be in use; in order to get sufficient illumination more of them must be lighted than would be necessary if lamps in good condition were used. A dim lamp takes practically as much current as a new one, and is a very wasteful thing to use. With lamps in good condition, the light will not be efficiently produced if the electric company allows the voltage to be low.

In this connection it may be well to state that the tungsten lamp has been improved in quality and reduced in price to such an extent that no customer can afford to use carbon lamps, even if he were paid a bonus on each lamp for so doing. Many householders cling to the use of carbon lamps because they are usually supplied free. The folly of this course may be realized from the following statement: the cost of a lamp is reckoned in cents, but the cost of the energy to operate it during its life is a matter of dollars. The energy cost for a tungsten lamp is only about one-third that of the carbon lamp.

4. Lamps are sometimes left burning for days in attics, closets and other out of the way places.

5. Electric laundry irons, toasters or other heating devices may have been placed in service or used more than in former months. Motor-driven devices may have been installed.

Many devices which are operated through flexible cord from a lamp socket take very much more power than any lamp which

would be used in the household. It is often erroneously believed that because such devices can be operated from a socket they require no more power than a lamp. The extent of this error may be realized from the statement that a 6-pound laundry iron takes as much power as 20 tungsten lamps of about 20 candlepower each.

6. Defective wiring may allow current to flow when no lights or other devices are in use.

7. Where electric elevators or electrically driven machinery is used and not properly oiled and cared for, excessive friction may result, with a corresponding waste of power and increase in the bill for electric current.

8. An error may be made by the company's meter reader, so that the bill rendered is too high or too low. If it is too high, the bill for the following month will be low by the same amount, if the meter is then read correctly, so that the consumer will not usually lose anything in the long run. When a minimum monthly charge is made by the company, the consumer may lose in the long run. Hence, if an error has apparently been made by the meter reader, the company should be requested to investigate the matter and to render a corrected bill if an error is found.

Electricity Comparatively Inexpensive.

An erroneous idea is abroad in the land that electricity, except for lighting perhaps, is tremendously expensive. Nothing is farther from the truth, as a little investigation plus a little arithmetic will prove.

The accompanying table of various electrical devices commonly used in the home will give an idea of the amount of power required to operate the devices and may be used in estimating the cost of operation. The cost to operate each of these for one hour is based on a charge of 10 cents per kilowatt hour.

For example, to find the cost of operating a 25-watt Mazda lamp for one hour at a charge of 10 cents per kilowatt hour, divide 25 by 1,000, and, multiplying this result by 10 (charge per kilowatt hour), we find the product to be 0.25 watt. Therefore the cost is ¼ of a cent per hour.

Apparatus.	Watts used.	Cost in Cents per Hour.
20 candlepower Mazda lamp,	25	¼
Radiant toaster,	600	6
Chafing dish,	600	6
Disc stove,	600	6
Coffee percolator,	450	4½
6-pound iron,	550	5½
8-inch fan (full speed),	25	¼
Sewing machine motor,	55[1]	½
Ice cream freezer,	400[1]	4
Washing machine motor,	200[1]	2
Luminous radiator (small),	500	5
Heating pad,	22–44[1]	¼–½
Tubular air heater (small),	1,200	12
Tea kettle,	500	5
Ozonator,	15	3–20
Domestic buffing and grinding motor,	55[1]	½
Radiant grill,	600	6

The above table gives an idea of the low cost of operating the many conveniences adapted for household use.

One cent's worth of electricity —

Will operate a 12-inch fan for two hours.
Will operate a sewing machine motor for two hours.
Will keep a 6-pound flatiron hot for twenty minutes.
Will keep a heating pad hot for two hours.
Will run a massage machine for two hours.
Will run an electric pianola for one hour.
Will keep a glue pot hot for one hour.
Will pump 250 gallons of water 100 feet high.[2]
Will raise a large passenger elevator five stories a minute.[2]
Will give light of 24 candles for four hours.
Will operate a vacuum cleaner for forty-five minutes.
Will wash 5 tubs of clothes.
Will protect your house from burglars one night.
Will run an automobile one mile.
Will in a family of 10 cook for one person one meal.

[1] Average. [2] At power rate of 5 cents per kilowatt hour; other items at 10 cents per kilowatt hour.

WATER.

Accuracy of Water Meters.

Water meters are commercially accurate instruments. Cases of meters which register correctly when installed and overregister after being in service are very rare. Any derangement of the meter from dirt entering the working parts or from other causes is likely to slow the meter down and cause it to underregister. There is a small amount of unavoidable leakage through the meter which causes it to underregister when very small quantities of water are passing.

FIG. 16. — Form of direct-reading water-meter dial.

Meters for measuring water for domestic use are usually graduated in cubic feet — sometimes in gallons. One cubic foot is taken commercially as equal to $7\frac{1}{2}$ gallons. Hence, to reduce a meter reading in cubic feet to gallons, multiply the number of cubic feet by $7\frac{1}{2}$.

Reading of Water Meters.

The ordinary form of dial is shown in Fig. 17. In Fig. 16 is shown a special form of register which is more convenient to read. It is known as a straight-line register and gives cubic feet or gallons directly.

In Fig. 17 the unit is cubic feet, and is plainly marked on the dial. If the unit were gallons, the method of reading would be the same. The hands revolve around circles, each divided into 10 numbered divisions. The number on the outside of each circle indicates the number of cubic feet for one complete revolution of the hand. The divisions of the circles are numbered alternately in the counter clockwise and clockwise direction. Thus, the first dial (at the bottom) is marked 10 and one division measures 1 cubic foot, the second 100

and one division measures 10 cubic feet, the next is marked 1,000 and one division measures 100 cubic feet, and similarly for the rest. The small dial at the left measuring 1 cubic foot for a complete revolution is disregarded in reading the meter, being used for test purposes. One division of a circle is equal to a complete revolution of the hand on the next lower circle. When a hand is between two figures the lesser is to be taken. If a hand is very near a figure, whether that figure or the next lower is to be taken can be determined by observing the hand in the next lower circle. Unless the hand on this circle has reached or just passed 0, the lesser figure is to be taken. The best method of reading is from low to high, that is from right to left. For example, reading the dial shown in Fig. 17 and setting down the figures successively from right to left, we have 7 for units place, 6 for tens place, 8 for hundreds place, and 1 for thousands place and for ten-thousands place, or 11,867 cubic feet.

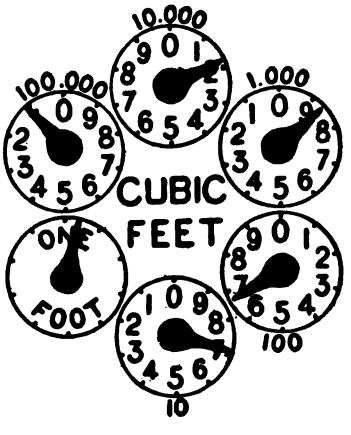


FIG. 17. — Ordinary form of water-meter dial.

Reading 11,867 cubic feet.

The circles on different makes of dial may be differently located on the dial, but the method of reading is the same as given.

In meters larger than those ordinarily used for household measurement the lowest graduated circle, the one marked 10, corresponding to units place in the reading, is sometimes omitted, the lowest circle being then the one marked 100. In this case the meter is read exactly as described above, and a zero added in the units place.

The dial after reading cannot be set back to zero. The record is continuous. The amount of water which has passed through the meter in a given time is therefore obtained by subtracting the first reading from the last. For example, if the meter were read the thirtieth day of June and again the thirtieth day of July, the June reading is to be subtracted from that taken in July.

Using the Water Meter as a Measuring Appliance.

The amount of water required for a particular use — for example, in watering a lawn — may be determined by first turning off all other outlets and allowing the hose to run, say, half an hour, reading the meter at the beginning and end of the period and subtracting the first reading from the second.

Since the meter can only register when water is passing through, should the hands move when all outlets are closed, water is being wasted through some leak. This can be most easily detected by observing the circle marked "one foot," referred to above as being provided for purposes of test.

FIG. 18. — Water leaks of various sizes.

Conservation of Water Supplies.

The elimination of water waste is a subject which should enlist the attention of all. In many of the smaller communities the source of supply does not furnish a sufficient quantity during dry seasons, while in more populous sections the prodigious waste of water threatens the adequacy of present supplies for the rapidly growing populations. With waste unchecked, it becomes necessary to locate additional sources of supply and to construct new water works, involving the expenditure of large sums of money.

As an adequate water supply is absolutely essential for health and comfort, as well as for protection from fire, willful waste of this precious commodity is unpardonable. Wherever water service is metered, unnecessary waste is reflected in the water bills and thus suggests its own remedy, but the economic effect is the same whether the financial burden rests upon the individual or the municipality.

Have you any defective water pipes or leaky fixtures on your property?

Do you know what they cost you for water each day that they are allowed to remain in this condition?

Do you or your tenants allow water to run to waste when not in use?

Under average conditions in the cities of this Commonwealth the amount of water wasted, and the gross cost of the same for the several sizes of streams shown above, will be approximately as follows:—

Stream.	Gallons per Hour.	Cost per Day.
1 inch,	3,225	$15 48
¾ inch,	2,812	13 50
½ inch,	1,596	7 66
¼ inch,	473	2 27
⅛ inch,	170	82
1/16 inch,	37	18
1/32 inch,	16	08
1/64 inch,	2.5	01

MEASUREMENTS OF TIME.

Correct Time.

In practically all towns in the United States the so-called *correct* time is the standard time of the *standard time section* in which the town is located. This country is divided into four standard time sections, designated by the names Eastern, Central, Mountain and Pacific sections, or by the meridians of longitude which are nominally the middle of the sections, namely, the seventy-fifth, ninetieth, one hundred and fifth, and one hundred and twentieth. Each section is thus theoretically 15 degrees of longitude in width, the section central about the seventy-fifth meridian extending from longitude 67° 30′ to 82° 30′, the ninetieth meridian section extending from 82° 30′ to 97° 30′, etc. Practically, however, the boundaries of the sections are irregular, broken lines connecting the terminal or division points at which the various railroads change their time in passing from one section to another. Thus, the boundary between

the Eastern and Central time sections extends, roughly, from Sault Ste. Marie, Mich., through Lake Huron to Detroit, Mich., thence through Lake Erie to Buffalo and then southward through western Pennsylvania to Atlanta and Savannah, Ga.

All the clocks in any one time section would read the same if they were *correct,* and the clock time indicated by them would differ from that of the adjoining time sections by just one hour, the time of the section to the west being one hour slower, and that of the section to the east one hour faster, for each time section uses the mean solar time of its central meridian.

Care of Timepieces.

Precautions should be taken not only with clocks but also with watches to keep them at a constant temperature if one wishes to obtain the best results with them. If possible a watch should be kept at as nearly the same temperature at night as during the day. The variations with the drop in temperature at night will affect the rate of the alarm clock, uncompensated for temperature, much more than that of a watch, which is usually compensated for high and low temperatures.

The careful handling of a timepiece of the balance-wheel type — clock or watch — is also important, because of the effect on the adjustment and rate. All sudden changes of motion should be avoided, and a fall is liable to bend some of the pivots and seriously change the rate. The position in which it is kept also makes a large difference in its rate, especially with the unadjusted cheaper types. Both the watch and the clock should best be kept in an upright position, both day and night, as uniformity of practice is the chief essential. All timepieces should, of course, be kept protected from dust and dirt. They should be wound regularly. It is perhaps better to wind a watch twice a day than once a day, if it is done regularly, and the last part of the winding should be done slowly, to avoid injury to the mechanism.

Use of a Timepiece in the Kitchen.

Many operations in the kitchen may be judged most easily and accurately by means of the elapsed time, especially where the operation is carried out under uniform conditions, as, for example, the

boiling of food or even of baking where the heat supplied is continuous and uniform in its rate of application.

The most familiar case is, of course, the boiling of eggs. With a little experience and the keeping of a record of results, the same principle can be applied to cooking other foods to the most palatable condition. Such records will also be valuable in determining for future use the time necessary for the preparation of food materials.

Even if interest in such methods is lacking, an alarm clock may be made very useful in giving a warning of the necessity of inspecting a given process which otherwise might be overlooked, and where food materials are frequently spoiled in preparation from lack of attention, the use of an alarm clock will soon save its cost.

In using the alarm feature of an alarm clock, the setting mechanism should be turned in one direction only, for the same reason as in the case of setting a clock with striking mechanism to correct time, to avoid locking or breaking the setting device. Occasionally the indicating hand of the alarm will not be placed correctly on its pinion and the alarm will sound at a different time from that expected. This error will be a constant one, however, and its amount having been once learned, allowance may be made for it in setting the hand; or a watch repairer can correct the fault very quickly. Many alarm clocks have the dial for setting the alarm of very small diameter, making it difficult to make accurate settings of the hand. For this use it is desirable to secure a clock with as large an alarm-hand dial as possible, preferably one having the alarm hand set on the central pinion with the hour and minute hands. With such a clock the alarm can be set quite accurately for giving a signal at short intervals of time, and can be used to give warnings of the time to inspect certain processes of the kitchen, for the taking of medicine at regular intervals, etc.

BRIEF REFERENCE TABLES OF WEIGHTS AND MEASURES.

Following will be found tables of units and special data regarding measurements. Many of the units used are somewhat vague and in some cases the terms are ambiguous. For example, the *ounce* used in the drug store is not the same as the ounce used in the grocery store, even when the same commodity is purchased, and the *fluid ounce* is different from either, and is not a weight at all. It

will thus be seen that for more careful work in connection with measurements the exact value of the units used should be clearly known.

Avoirdupois Weight.

27 11/32 grains (gr.)	= 1 dram (dr.).
16 dr.	= 1 ounce (oz.) = 437½ gr.
16 oz.	= 1 pound (lb.) = 256 dr. = 7,000 gr.
100 lb.	= 1 hundredweight (cwt.) = 1,600 oz.
20 cwt.	= 1 ton (t.) = 2,000 lb.
	(In long measure.)
112 lb.	= 1 cwt.
20 cwt.	= 1 long ton (t.) = 2,240 lb.

Troy Weight.

24 grains (gr.)	= 1 pennyweight (dwt.).
20 dwt.	= 1 ounce (oz.) = 480 grains.
12 oz.	= 1 pound (lb.) = 240 dwt. = 5,760 gr.

Apothecaries' Weight.

20 grains (gr.)	= 1 scruple (℈).
3 ℈	= 1 dram (ʒ) = 60 gr.
8 ʒ	= 1 ounce (℥) = 24 ℈ = 480 gr.
12 ℥	= 1 pound (℔) = 96 ʒ = 288 ℈ = 5,760 gr.

Linear Measure.

12 inches (in.)	= 1 foot (ft.).
3 ft.	= 1 yard (yd.) = 36 in.
5½ yd.	= 1 rod (rd.) = 16½ ft.
320 rd.	= 1 mile (mi.) = 1,760 yd. = 5,280 ft.

Linear Measures (Special).

1,000 mils	= 1 inch.
72 points	= 1 inch.
4 inches	= 1 hand.
7.92 inches	= 1 surveyor's link.
9 inches	= 1 span.
6 feet	= 1 fathom.
40 yards	= 1 bolt (cloth).
10 chains	= 1 furlong.
6,080.20 feet	= 1 nautical mile = 1.1516 statute miles.

Surveyor's Measure.

625 square links (sq. li.) = 1 square rod (sq. rd.).
16 sq. rd. = 1 square chain (sq. ch.).
10 sq. ch. = 1 acre (a.).
640 a. = 1 square mile (sq. mi.).
36 sq. mi. (6 mi. square) = 1 township (tp. = 23040 a.).

Chain Measure.

(Surveyors' or Gunter's Chain.)

7.92 inches = 1 link (li.).
100 li. = 1 chain (ch.) = 66 ft.
80 ch. = 1 mile (mi.).

The engineer's chain is 100 feet long and consists of 100 links.

Square Measure.

144 square inches (sq. in.) = 1 square foot (sq. ft.).
9 sq. ft. = 1 square yard (sq. yd.).
30¼ sq. yd. = 1 square rod (sq. rd.).
160 sq. rd. = 1 acre (a.).

Liquid Measure.

4 gills (gi.) = 1 pint (pt.).
2 pt. = 1 quart (qt.) = 8 gi.
4 qt. = 1 gallon (gal.) = 8 pt. = 32 gi.
31½ gal. = 1 barrel (bbl.) = 126 qt.
2 bbls. = 1 hogshead (hhd.) = 63 gal. = 252 qt.

Cubic Measure.

1,728 cubic inches (cu. in.) = 1 cubic foot (cu. ft.).
27 cu. ft. = 1 cubic yard (cu. yd.).

United States Dry Measure.

2 pints (pt.) = 1 quart (qt.).
8 qt. = 1 peck (pk.) = 16 pt.
4 pk. = 1 bushel (bu.) = 32 qt. = 64 pt.

Apothecaries' Fluid Measure.

60 minims (m.) = 1 fluid dram = (fl. dr.).
8 fl. dr. = 1 fluid ounce (fl. oz.) = 480 m.
16 fl. oz. = 1 pint (O.) = 128 fl. dr. = 7,680 m.
8 O. = 1 gallon (cong.) = 128 fl. oz. = 1,024 fl. dr.

Number of Cubic Inches in United States Standard Capacity Measures.

Dry Measure.

1 bushel contains 2,150.42 cubic inches.
½ bushel contains 1,075.21 cubic inches.
1 peck contains 537.60 cubic inches.
½ peck contains 268.80 cubic inches.
¼ peck contains 134.40 cubic inches.
1 quart contains 67.20 cubic inches.
1 pint contains 33.60 cubic inches.
½ pint contains 16.80 cubic inches.

Liquid Measure.

1 gallon contains 231 cubic inches.
½ gallon contains 115.5 cubic inches.
1 quart contains 57.75 cubic inches.
1 pint contains 28.875 cubic inches.
½ pint contains 14.437 cubic inches.
1 gill contains 7.218 cubic inches.
1 fluid ounce contains 1.804 cubic inches.
1 dram contains .225 cubic inches.

Paper Measure.

For small papers the old measure is still in use: —

24 sheets = 1 quire.
20 quires = 1 ream (480 sheets).

For papers put up in cases, bundles or frames the following measure is now used: —

25 sheets = 1 quire.
20 quires = 1 standard ream (500 sheets).

Carat and Karat.

Carat (for precious stones) = 200 milligrams. The carat was formerly an ambiguous term having many values in various countries.

Karat (fineness of gold) = $\frac{1}{24}$ (by weight) gold. For example, 24 karats fine = pure gold; 18 karats fine = $\frac{18}{24}$ pure gold.

THE METRIC SYSTEM.

The metric system is based on a unit of length (the *meter*). A cubical box one-tenth of a meter on the side has the unit of capacity, a *liter*, and the water contained in a liter weighs one kilogram. The unit of weight, the *gram*, in the metric system is the weight of water contained in a cubical box one-hundredth of a meter on a side.

(NOTE. — These values are not precisely correct, but hold for all but the most refined measurements.)

The entire system is then built up by multiplying or dividing the unit by ten, one hundred and one thousand, using always the same prefix to indicate what the unit is multiplied or divided by. There is but one standard of weight, but one standard of measure for liquids and dry commodities, and but one standard of length.

Tables.

PREFIXES.	Meaning Fractions or Decimals.		Units.
milli- = one-thousandth,	1-1000	.001	
centi- = one-hundredth,	1-100	.01	
deci- = one-tenth,	1-10	.1	"meter" for length.
unit = one,		1.	"gram" for weight.
deka- = ten,	10-1	10.	"liter" for capacity.
hecto- = one hundred,	100-1	100.	
kilo- = one thousand,	1000-1	1,000.	

The metric terms are formed by combining the words "meter," "gram" and "liter" with the six numerical prefixes.

OUTLINE TABLE.

Prefix.	Unit.
Ten milli-meters, grams or liters	= one centi-meter, gram or liter.
Ten centi-meters, grams or liters	= one deci-meter, gram or liter.
Ten deci-meters, grams or liters	= one meter, gram or liter.
Ten meters, grams or liters	= one deka-meter, gram or liter.
Ten deka-meters, grams or liters	= one hecto-meter, gram or liter.
Ten hecto-meters, grams or liters	= one kilo-meter, gram or liter.

The following tables are formed by inserting successively the names of the three units in the columns headed "unit" in the above Outline Table:—

Lengths.

Ten milli-meters = one centi-meter.
Ten centi-meters = one deci-meter.
Ten deci-meters = one meter.
Ten meters = one deka-meter.
Ten deka-meters = one hecto-meter.
Ten hecto-meters = one kilo-meter.

The square and cubic units are the squares and cubes of the linear units.

Weights.

Ten milli-grams = one centi-gram.
Ten centi-grams = one deci-gram.
Ten deci-grams = one gram (about 15 grains).
Ten grams = one deka-gram.
Ten deka-grams = one hecto-gram.
Ten hecto-grams = one kilo-gram.

Volumes.

Ten milli-liters = one centi-liter.
Ten centi-liters = one deci-liter.
Ten deci-liters = one liter (about 1 quart).
Ten liters = one deka-liter.
Ten deka-liters = one hecto-liter (about 1 barrel).
Ten hecto-liters = one kilo-liter.

The ordinary unit of land area is the hectar (100 meters square), and is equal to 100 ars. The hectar is about $2\frac{1}{2}$ acres.

TABLE OF EQUIVALENTS.

1 meter = 39.37 inches. (Legal equivalent adopted 1866.)

Where values given are not exact the equivalents are correct to 1 part in a thousand (0.001%).

Lengths.

Millimeters	1	= 0.03937	inch.
Millimeters	25.40	= 1	inch.
Centimeters	1	= 0.3937	inch.
Centimeters	2.540	= 1	inch.
Meter	0.305	= 1	foot.
Meter	1	= 3.28	feet.
Meter	0.914	= 1	yard.
Meter	1	= 1.094	yard.
Kilometer	1	= 0.621	mile.
Kilometer	1.61	= 1	mile.

Inches.	Millimeters.	Inches.	Centimeters.	Feet.	Meters.	U. S. Yards.	Meters.	U. S. Miles.	Kilometers.
0.03937 =	1	0.3937 =	1	1	= 0.304801	1	= 0.914402	0.62137 =	1
0.07874 =	2	0.7874 =	2	2	= 0.609601	1.093611 =	1	1	= 1.60935
0.11811 =	3	1	= 2.54001	3	= 0.914402	2	= 1.828804	1.24274 =	2
0.15748 =	4	1.1811 =	3	3.28083 =	1	2.187222 =	2	1.86411 =	3
0.19685 =	5	1.5748 =	4	4	= 1.219202	3	= 2.743205	2	= 3.21869
0.23622 =	6	1.9685 =	5	5	= 1.524003	3.280833 =	3	2.48548 =	4
0.27559 =	7	2	= 5.08001	6	= 1.828804	4	= 3.657607	3	= 4.82804
0.31496 =	8	2.3622 =	6	6.56167 =	2	4.374444 =	4	3.10685 =	5
0.35433 =	9	2.7559 =	7	7	= 2.133604	5	= 4.572009	3.72822 =	6
1	= 25.4001	3	= 7.62002	8	= 2.438405	5.468056 =	5	4	= 6.43739
2	= 50.8001	3.1496 =	8	9	= 2.743205	6	= 5.486411	4.34959 =	7
3	= 76.2002	3.5433 =	9	9.84250 =	3	6.561667 =	6	4.97096 =	8
4	= 101.6002	4	= 10.16002	13.12333 =	4	7	= 6.400813	5	= 8.04674
5	= 127.0003	5	= 12.70003	16.40417 =	5	7.655278 =	7	5.59233 =	9
6	= 152.4003	6	= 15.24003	19.68500 =	6	8	= 7.315215	6	= 9.65608
7	= 177.8004	7	= 17.78004	22.96583 =	7	8.748889 =	8	7	=11.26543
8	= 203.2004	8	= 20.32004	26.24667 =	8	9	= 8.229616	8	=12.87478
9	= 228.6005	9	= 22.86005	29.52750 =	9	9.842500 =	9	9	=14.48412

Areas.

Square millimeters	1	=	0.00155	square inch.
Square millimeters	645	=	1	square inch.
Square centimeters	1	=	0.155	square inch.
Square centimeters	6.45	=	1	square inch.
Square meter	0.0929	=	1	square foot.
Square meter	1	=	10.76	square feet.
Square meter	0.836	=	1	square yard.
Square meter	1	=	1.196	square yard.
Hectar	0.405	=	1	acre.
Hectar	1	=	2.47	acres.
Square kilometers	1	=	0.386	square mile.
Square kilometers	2.59	=	1	square mile.

Volumes.

Cubic centimeters	1	=	0.0610	cubic inch.
Cubic centimeters	16.39	=	1	cubic inch.
Cubic meter	0.0283	=	1	cubic foot.
Cubic meter	1	=	35.3	cubic feet.
Cubic meter	0.765	=	1	cubic yard.
Cubic meter	1	=	1.308	cubic yard.

Capacities.

Cubic centimeters (milliliters)	1	=0.0338	United States liquid ounce.
Cubic centimeters (milliliters)	29.57	=1	United States liquid ounce.
Cubic centimeters (milliliters)	1	=0.2705	United States apothecary dram.
Cubic centimeters (milliliters)	3.70	=1	United States apothecary dram.
Liter	0.946	=1	United States liquid quart.
Liter	1	=1.057	United States liquid quart.
Liter	1	=0.2642	United States liquid gallon.
Liter	3.785	=1	United States liquid gallon.
Liter	1	=0.908	United States dry quart.
Liter	1.101	=1	United States dry quart.
Dekaliter	0.881	=1	United States peck.
Dekaliter	1	=1.135	United States peck.
Hectoliter	0.3524	=1	United States bushel.
Hectoliter	1	=2.838	United States bushels.

Weights.

Gram	0.0648	=	1	grain.
Gram	1	=15.43		grains.
Gram	1	=	0.772	United States apothecary scruple.
Gram	1.296	=	1	United States apothecary scruple.
Gram	1	=	0.2572	United States apothecary dram.
Gram	3.89	=	1	United States apothecary dram.
Gram	1	=	0.0353	avoirdupois ounce.
Gram	28.35	=	1	avoirdupois ounce.
Gram	1	=	0.03215	troy ounce.
Gram	31.10	=	1	troy ounce.
Kilogram	0.4536	=	1	avoirdupois pound.
Kilogram	1	=	2.205	avoirdupois pounds.
Kilogram	0.373	=	1	troy pound.
Kilogram	1	=	2.679	troy pounds.
Metric ton	1	=	0.984	gross or long ton.
Metric ton	1.016	=	1	gross or long ton.
Metric ton	0.907	=	1	short or net ton.
Metric ton	1	=	1.102	short or net ton.

For all practical purposes the volume of 1 kilogram of water (1 liter) is equal to 1 cubic decimeter.

Phys 429.17.3
Measurements for the household.
Cabot Science 003439633
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